Patent Claims

1. Method for training a neural network that contains pulsed neurons,

a) the neural network is trained such for a first time span ([0; T]) that a discrimination value is maximized, as a result whereof a maximum first discrimination value is formed;

b) the discrimination value is formed dependent on pulses that are formed by the pulsed neurons within the first time span as well as on a training sequence of input quantities that are supplied to the neural network;

c) the following steps are interactively implemented:

-- the first time span is shortened to form a second time span,

-- a second discrimination value is formed for the second time span,

-- when the second discrimination value is the same as the first discrimination value, then a new iteration ensues with a new second time span that is formed by shortening the second time span of the preceding iteration,

-- otherwise, the method is ended and the trained neural network is the neural network of the last iteration wherein the second discrimination value is the same as the first discrimination value.

2. Method according to claim 1, whereby an optimization method that is not gradient based is utilized for the maximization of the first discrimination value and/or of the second discrimination value.

3. Method according to claim 2, whereby the optimization method is based on the ALOPEX method.

4. Method according to one of the claims 1 through 3, whereby the first discrimination value I(T) satisfies the following rule:

$$I(T) = I\left(s; \begin{Bmatrix} t_1^{(1)}, \ldots, t_m^{(1)}, \ldots, t_{k_1}^{(1)}, t_1^{(2)}, \ldots, t_m^{(2)}, \ldots, t_{k_2}^{(2)}, \ldots, \\ t_1^{(n)}, \ldots, t_m^{(n)}, \ldots, t_{k_n}^{(n)}, \ldots, t_1^{(N)}, \ldots, t_m^{(N)}, \ldots, t_{k_N}^{(N)} \end{Bmatrix}\right),$$

whereby

- s references the input quantities,

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- $t_m^{(n)}$ references a pulse that is generated by a pulsed neuron n at a time m within a time span [0, T],
- k_n (n = 1, ..., N) references a point in time at which the pulsed neuron n has generated the last pulse within the time span [0, T],
- N references a plurality of pulsed neurons contained in the neural network.

5. Method according to claim 4, whereby the first discrimination value I(T) satisfies the following rule:

$$I(T) = -\int p(out) \cdot \ln(p(out)) dt_1^{(1)} \ldots dt_{k_1}^{(1)} \ldots dt_{k_N}^{(N)} + \\ + \sum_{j=1}^{S} p_j \int p\left(out \middle| s^{(j)}\right) \cdot \ln\left(p\left(out \middle| s^{(j)}\right)\right) dt_1^{(1)} \ldots dt_{k_1}^{(1)} \ldots dt_{k_N}^{(N)}$$

with

$$p(out) = \sum_{j=1}^{S} p_j p\left(out \middle| s^{(j)}\right),$$

whereby

- $s^{(j)}$ references an input quantity that is applied to the neural network at a time j,
- p_j references a probability that the input quantity $s^{(j)}$ is applied to the neural network at a pint in time j,
- $p(out|s^{(j)})$ references a conditioned probability that a pulse is generated by a pulsed neuron in the neural network under the condition that the input quantity $s^{(j)}$ is applied to the neural network at a point in time j.

6. Method according to one of the claims 1 through 5, whereby the training sequence of inputs quantities are [sic] measured physical signals.

7. Method according to claim 6, whereby the training sequence of input quantities are [sic] signals of an electroencephalogram.

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8. Method for the classification of a sequence of input quantities upon employment of a neural network that contains pulsed neurons and was trained according to the following steps:

a) the neural network is trained such for a first time span that a discrimination value is maximized, as a result whereof a maximum first discrimination value is formed;

b) the discrimination value is formed dependent on pulses that are formed by the pulsed neurons within the first time span as well as on a training sequence of input quantities that are supplied to the neural network;

c) the following steps are interactively implemented:

-- the first time span is shortened to form a second time span,

-- a second discrimination value is formed for the second time span,

-- when the second discrimination value is the same as the first discrimination value, then a new iteration ensues with a new second time span that is formed by shortening the second time span of the preceding iteration,

-- otherwise, the method is ended and the trained neural network is the neural network of the last iteration wherein the second discrimination value is the same as the first discrimination value,

-- whereby the sequence of input quantities is supplied to the neural network;

-- whereby a classification signal is formed that indicates what kind of sequence of input quantities the supplied sequence is.

9. Method according to claim 9, whereby the training sequence of input quantities and the sequence of input quantities are measured physical signals.

10. Method according to claim 9, whereby the training sequence of input quantities and the sequence of input quantities are measured signals of an electroencephalogram.

11. Neural network that contains pulsed neurons has been trained according to the following steps:

a) the neural network is trained such for a first time span that a discrimination value is maximized, as a result whereof a maximum first discrimination value is formed;

b) the discrimination value is formed dependent on pulses that are formed by the pulsed neurons within the first time span as well as on a training sequence of input quantities that are supplied to the neural network;

c) the following steps are interactively implemented:

-- the first time span is shortened to form a second time span,

-- a second discrimination value is formed for the second time span,

-- when the second discrimination value is the same as the first discrimination value, then a new iteration ensues with a new second time span that is formed by shortening the second time span of the preceding iteration,

-- otherwise, the method is ended and the trained neural network is the neural network of the last iteration wherein the second discrimination value is the same as the first discrimination value.

12. Neural network according to claim 10, utilized for the classification of a physical signal.

13. Neural network according to claim 10, utilized for the classification of a physical signal.

14. Arrangement for training a neural network that contains pulsed neurons comprises a processor that is configured such that the following steps can be implemented:

a) the neural network is trained such for a first time span that a discrimination value is maximized, as a result whereof a maximum first discrimination value is formed;

b) the discrimination value is formed dependent on pulses that are formed by the pulsed neurons within the first time span as well as on a training sequence of input quantities that are supplied to the neural network;

c) the following steps are interactively implemented:

-- the first time span is shortened to form a second time span,

-- a second discrimination value is formed for the second time span,

-- when the second discrimination value is the same as the first discrimination value, then a new iteration ensues with a new second time span that is formed by shortening the second time span of the preceding iteration,

-- otherwise, the method is ended and the trained neural network is the neural network of the last iteration wherein the second discrimination value is the same as the first discrimination value.

15. Arrangement according to claim 14, utilized for the classification of a physical signal.

16. Arrangement according to claim 14, utilized for the classification of a signal of an electroencephalogram.